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International Patent Application No. PCT/DK2005/000230
Applicant: Weibel Scientific A/S
System and method for radar detection of an object
Our ref.: P928PC00 – SHG/kjn

Dear Sirs,

We refer to your letter of 4 November 2005 transmitting the International Search Report and the Written Opinion for this PCT application and hereby file a demand for international preliminary examination, together with a fee calculation sheet *(only by fax)*. We respectfully request detailed preliminary examination of the application.

Moreover, with reference to the first written opinion dated 4 November 2005, we submit the following response:

Claims

We enclose a new, amended set of claims 1-36, replacing the previously filed claims 1-122.

In the new set of claims, the new independent claim 1 has basis in previously filed claims 6, 10, 13, 17, 19 and 20; the new independent claim 9 has basis in previously filed claims 6, 10, 13, 19, 20, 23, 24, 25 and 26; the new independent claim 13 has basis in previously filed claims 6, 10, 13, 17, 19, 20, 29, 36, 40, 49 and 52, and the originally filed description, page 10, lines 7-14, and page 10, line 31 to page 11, line 3; and the new independent claim 22 has basis in previously filed claims 6, 10, 13, 19, 20, 21, 23, 25, 29, 35, 45 and 46, and the originally filed description, page 9, lines 17-28.

The previously filed claims 1-5 and 62-122 have been cancelled, and new dependent claims correspond to previously filed claims as listed below:

New claim	Previous claim
2	29
3	36 and 40
4	37 and 41
5	23
6	24
7	25
8	26
10	21
11	17
12	18
14	21
15	24
16	26
17	37 and 41
18	18
19	33
20	34
21	44 and the originally filed description page 9, lines 30-34
23	24 and 26
24	7
25	8
26	9
27	22
28	27
29	28
30	50
31	53
32	55
33	56
34	57
35	58
36	59

Prior art

The new independent claims 1, 9, 13 and 22 have all been amended so as to include claims from the group of previously filed claims 10-61. Thus, all the new independent claims are formed on basis of the third invention, when referring to the group of inventions mentioned in the written opinion.

For the third invention, the documents D1, D3, D4 and D5 are cited as prior art:

D1: US 3,120,659
D3: US 5,731,778
D4: GB 2,380,682
D5: EP 0 766 100

Claim 1

The present invention according to the new independent claims 1 covers:

A radar system having:
a radar wave transmitter for simultaneously transmitting a CW radar signal and a FM-CW radar signal,
three separate receivers arranged along two different directions, and for each receiver
a CW mixer for mixing transmitted and reflected CW signals, and
a FM-CW mixer for mixing transmitted and reflected FM-CW signals.

Thus, from the system provided by the present claim 1, there is a simultaneous transmission of CW and FM-CW radar signals, whereby the observation time required to obtain unambiguous range and velocity measurements of a target object is reduced resulting in an increased system sensitivity. Furthermore, there are three separate receivers arranged in two different directions with each receiver having corresponding CW mixers and FM-CW mixers, which allows for the determination of two different target angels for both reflected CW signals and reflected FM-CW signals.

Document D1 discloses a radar system for simultaneous transmission of a CW and a FM-CW signal. The system of D1 has a single receiver with a corresponding CW mixer and a corresponding FM-CW mixer. However, as the system of D1 has only one receiver, it is not possible to determine any phase differences for reflected signals received by two or more separate receiver channels. Furthermore, the system of D1 has no FFT processing.

Documents D3 and D5 disclose a FM-CW radar system with two separate receivers (Fig. 1 of D3 and D5), FFT processing and peak determination in each of these two channels, whereby a single target (azimuth) angle can be determined. D5 (see Fig. 20) also discloses a FM-CW radar system with three separate receivers. However, these three receivers are arranged in one line (see page 15, lines 11-18), to thereby double the azimuth detection range. It is nowhere in D3 or D5 suggested that three separate receivers could be arranged along two different directions, which would make it possible to determine two different target angles.

Furthermore, it is nowhere in D3 or D5 suggested to have a simultaneous transmission of CW and FM-CW radar signals, whereby the observation time required to obtain unambiguous range and velocity measurements of a target object can be reduced, resulting in a increased system sensitivity.

Document D4 discloses a CW radar system with three receivers arranged in two directions (Fig. 4 of D4) to determine, from phase differences between the receiver channels, target angle in a horizontal and a vertical direction. However, in D4 there is no transmission of a FM-CW signal, and the phase differences can only be determined from reflected CW signals. Furthermore, it is nowhere in D4 suggested to have a simultaneous transmission of CW and FM-CW radar signals.

When combining D1 and D5 or D3, there is obtained a system with simultaneous transmission of a CW and a FM-CW signal and with two or three receivers arranged in a single line, where all two or three receivers have FM-CW mixers, while only one receiver has both a CW mixer and a FM-CW mixer. By use of such a system, it is only possible to obtain a determination of a single target angle and only for FM-CW signals, and it is not possible to obtain a determination of two different target angels, neither for reflected CW signals nor for reflected FM-CW signals.

When combining D1 and D4, there is obtained a system with simultaneous transmission of a CW and a FM-CW signal and with three receivers arranged in two directions, where all three receivers have

CW mixers, while only one receiver has both a CW mixer and a FM-CW mixer. By use of such a system, it is not possible to obtain a determination of two different target angels for reflected FM-CW signals.

Thus, none of the above mentioned combinations provides a radar system having three separate receiver channels arranged in *two* directions, where *each* of the *three* receiver channels has *both* a CW mixer for mixing transmitted and reflected CW signals, and a FM-CW mixer for mixing transmitted and reflected FM-CW signals. Even a combination of D1, D4 and D5 does not provide such a system.

Claim 9

The present invention according to the new independent claims 9 covers:

A radar system having;
a radar wave transmitter for simultaneously transmitting a CW radar signal and a FM-CW radar signal,
three separate receivers arranged along two different directions, and for each receiver
a CW mixer for mixing transmitted and reflected CW signals, and
a FM-CW mixer for mixing transmitted and reflected FM-CW signals, wherein
for each CW mixer there is means for taking the Fourier transform, and wherein the system further has means for summing the Fourier outputs corresponding to each of the CW mixers, and/or wherein for each FM-CW mixer there is means for taking the Fourier transform, and wherein the system further has means for summing the Fourier outputs corresponding to each of the FM-CW mixers.

Here, the new claim 9 corresponds to the new claim 1 with the addition of the features of the previous claims 23 plus 24 and/or claims 25 plus 26. The features of claims 24 or 26 are not known from any of the cited prior art documents, neither are these features known from a combination of any of the cited prior art documents.

Claim 13

The present invention according to the new independent claims 13 covers:

A radar system having:
a radar wave transmitter for simultaneously transmitting a CW radar signal and a FM-CW radar signal,
three separate receivers arranged along two different directions, and for each receiver
a CW mixer for mixing transmitted and reflected CW signals, and
a FM-CW mixer for mixing transmitted and reflected FM-CW signals, wherein
the system further has phase detecting means for detecting a first phase difference relating to a first object angular direction for reflected CW or FM-CW signals, and for detecting a second phase difference relating to a second object angular direction for reflected CW or FM-CW signals, and wherein the system further has means for establishing and maintaining one or more CW track records, and/or means for establishing and maintaining one or more FM-CW track records.

Here, the new claim 13 corresponds to the new claim 1 with the addition of the features of the previous claims 29, 36, 40 and the addition of features from previous claim 49 and/or claim 52. The included features of claims 49 or 52 are not known from any of the cited prior art documents, neither are these features known from a combination of any of the cited prior art documents.

Claim 22

The present invention according to the new independent claims 22 covers:

A radar system having:
a radar wave transmitter for simultaneously transmitting a CW radar signal and a FM-CW radar signal,
four separate receivers arranged along a horizontal and a vertical direction, and for each receiver
a CW mixer for mixing transmitted and reflected CW signals, and
a FM-CW mixer for mixing transmitted and reflected FM-CW signals, wherein
for each CW mixer there is means for taking the Fourier transform and for each FM-CW mixer there is means for taking the Fourier transform, and wherein
the system further has phase detecting means for detecting a phase differences for reflected CW or FM-CW signals,

wherein the phase detecting means are adapted to determine an azimuth phase difference between the sum of the two Fourier transformed outputs corresponding to the first and third receivers and the sum of the two Fourier transformed outputs corresponding to the second and fourth receivers, and/or

wherein the phase detecting means are adapted to determine an elevation phase difference between the sum of the two Fourier transformed outputs corresponding to the first and second receivers and the sum of the two Fourier transformed outputs corresponding to the third and fourth receivers.

Here, the new claim 22 corresponds to the new claim 1 with the addition of the features of the previous claims 21, 23, 25, 29, 35 and the addition of features from previous claim 45 and/or claim 46. The included features of claims 45 or 46 are not known from any of the cited prior art documents, neither are these features known from a combination of any of the cited prior art documents.

Thus, it is believed that the new, amended independent claims 1, 9, 13 and 22 are all both novel and non-obvious in view of the cited documents D1-D5.

The applicant respectfully requests that the Examiner acknowledges novelty and industrial applicability of the claims amended as described above. In case the Examiner intends to issue a preliminary examination report not acknowledging novelty and inventive step of the claimed invention, the applicant requests either

- a telephone interview (Rule 66.6 PCT) or
- a second written opinion.

Please acknowledge safe receipt of this letter by returning the enclosed EPO Form 1037.

Yours sincerely,
HØIBERG A/S

Kim P. Jensen (Mr.)
(legal assistant to Susanne Høiberg)

PCT Demand
Amended claims
EPO Form 1037